SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion(W), Mumbai – 400022

Program: M.Sc.

Course: Microbiology

Syllabus for M.Sc. Part I

As per National Education policy (2020)

To be implemented from the academic year

2023-24

Preamble

With the introduction of National Education Policy from the academic year 2023-24; the syllabus for the M.Sc. Part I Microbiology has been drafted to cover the many aspects of the subject. In order to assist students in developing research skills in general and in specific area of their interest/specialization in particular, research proposal & research project component has been introduced in the new syllabus. This component will provide students with an opportunity to conduct independent research in the subject of Microbiology at their own P.G. centres and if the research project demands, in conjunction with relevant industries/ research institutes. Topics like Research Methodology, Biostatistics, Bioinformatics & Biomolecular analysis have been introduced in the new syllabus. In order to enable students to develop employable skills concurrently with an understanding of theoretical foundations and practical techniques required in R &D and quality control component such as on job training/ field project has been introduced in the second semester of the new syllabus.

As mentioned in the syllabus, mandatory papers of six credits, elective paper of four credit, two credit paper, research methodology paper of 4 credits and on job training/field project of 4 credits are compulsory for completing PG diploma in MSc Microbiology.

Semester I Theory Papers

Mandatory Paper I			
Course code	**Unit**	**Title**	**Credits**
		Cell Biology and Virology	4
	I	Membrane structure and transport	
	II	Cytoskeleton, Apoptosis, cell junction & adhesion.	
	III	Cell biology techniques	
	IV	Bacterial and animal viruses	
Mandatory Paper II			
Course code	**Unit**	**Title**	**Credits**
		Genetics	4
	I	Eukaryotic gene expression and Regulation	
	II	Mendelian and Human Genetics	
	III	Cytoplasmic inheritance	
	IV	Molecular tools for genetics and population genetics	
Two credit Theory Paper			
Course code	**Unit**	**Title**	**Credits**
		Basics of Biostatistics	2
	I	Concepts in Biostatistics	
	II	Parametric and Non-parametric tests	

Elective paper			
Course code	**Unit**	**Title**	**Credits**
		Microbial Biochemistry I	3
	I	Bioorganic molecules	
	II	Metabolism of one & two carbon compounds	
	III	Transfer of Biomolecules	
Research Methodology			
Course code		**Title**	**Credits**
		Research Methodology	3
	I	Research fundamentals and terminologies	
	II	Defining research problem and sampling	
	III	Data collection, data processing and Report writing	

Semester I Practical papers

Course code	Title	Credits
	Cell Biology and Virology	2
	Genetics	2
	Microbial Biochemistry I	1
	Research Methodology	1

Semester II Theory Papers

Mandatory Paper I			
Course code	**Unit**	**Title**	**Credits**
		Cell Biology and Developmental Biology	4
	I	Cell division and cell cycle	
	II	Cell signalling and Cancer genetics	
	III	Developmental biology Part I	
	IV	Developmental biology Part II	
Mandatory Paper II			
Course code	**Unit**	**Title**	**Credits**
		Advanced Immunology	4
	I	Immune System and Health : Part I	
	II	Immune System and Health : Part II	
	III	Recent advances in Immunology	
	IV	Challenges in Immune System	
Two credit Theory Paper			
Course code	**Unit**	**Title**	**Credits**
		Basics of Bioinformatics	2
	I	Bioinformatics I	
	II	Bioinformatics II	

Elective paper			
Course code	**Unit**	**Title**	**Credits**
		Microbial Biochemistry II	3
	I	Enzymology	
	II	Signalling and stress	
	III	Microbial degradation	

Semester II Practical papers

Course code	Title	Credits
	Cell Biology and Developmental Biology	2
	Advanced Immunology	2
	Microbial Biochemistry II	1

Course code	Title	Credits
	On Job training/ Internship/ Minor project	4

Semester I

Course Code:

Course title: Cell Biology and Virology

Course outcomes

After completion of this course students will be able to:

1) Describe cell membrane structure in detail and explain the principles of membrane transport.
2) Discuss intracellular compartments and vesicular traffic with details.
3) Outline the transport of proteins into various cell components.
4) Explain function and mechanism of cytoskeleton of the cell.
5) Describe cell junctions and adhesion with emphasis on their importance in cell interaction and communication.
6) Explain the pathways of programmed cell death with emphasis on its role.
7) Apply the different cell study techniques to identify, compare and examine the cells from biological samples for various purposes.
8) Discuss epidemiology and key characteristics of animal and bacterial viruses with emphasis on its role in research and medicine.

Detailed Syllabus

Mandatory paper I: Cell biology and Virology

Unit	Sub-unit	Title	Lectures
I		**Membrane structure and transport**	**15**
	1	Cell Membrane structure and composition: Membrane lipids, Membrane proteins and Membrane carbohydrates	4
	2	Membrane transport: Types of membrane transport, channels & pumps associated with transport and electrical property of membrane	4

	3	Intracellular compartments and protein sorting	4
	4	Endomembrane system and vesicular transport	3
II	**Cytoskeleton, Apoptosis, cell junction & adhesion.**		**15**
	1	Cytoskeleton filaments: Microtubules, Actin filaments & Intermediate filaments, Types of Molecular motors	5
	2	Apoptosis: Intrinsic & Extrinsic pathways of apoptosis	4
	3	Cell junction & adhesion: ECM, types of cell junctions and adhesions, and Cell interactions	6
	Cell Biology techniques		**15**
III	1	Visualisation of Cells: Phase contrast, Fluorescence and Electron microscopy	5
	2	Cell separation and sorting: Density gradient centrifugation, Flow cytometer and FACS, & Cell viability assays	5
	3	Genomic DNA and RNA Isolation, Karyotyping, FRAP analysis & Cell preservation techniques	5
	Virology: Bacterial and Animal viruses		**15**
IV	1	Bacteriophage: Structural Properties, Genetic organization, growth cycle, Replication ofDNA & Regulation of transcription of T4 and T7	7
	2	Animal Viruses: Classification, epidemiology, pathogenesis, immunity, viral life cycle, genetic variation, clinical symptoms, laboratory diagnosis and treatment for Rabies, Pox and Herpese Viruses	8

Practical:

1. Study of Cell membrane integrity using uptake of neutral red dye.
2. Cell viability Assay using trypan blue
3. Diffusion studies of molecules across sheep RBCs.
4. Isolation and purification of coliphage from sewage
5. Study of one step growth curve of bacteriophage

References:

Unit 1

1. Molecular Biology of The Cell - Albert, Johnson, Lewis, Raff, Roberts and Walter.
2. Cell and molecular biology – Gerald Karp, Janet Iwasa, and Wallace F. Marshall
3. The Cell: A Molecular Approach - Geoffrey Cooper

Unit 2

1. Molecular Biology of The Cell – Albert, Johnson, Lewis, Raff, Roberts and Walter.
2. Cell and molecular biology – Gerald Karp, Janet Iwasa, and Wallace F. Marshall
3. The Cell: A Molecular Approach - Geoffrey Cooper

Unit 3

1. Methods in cell biology - Shai Shaham, The Rockefeller University, New York.
2. Culture of Animal Cells – R. Ian Freshney.
3. Fundamentals techniques in cell culture – sigma Aldrich

Unit 4

1. Animal Virology – Fenner and White. Academic Press. NY
2. Understanding Viruses – Teri Shors. Jones and Bartlett pub.
3. Bacterial and Bacteriophage Genetics – Edward Birge
4. Essentials of molecular biology – Freifelder, David

Course Code:

Course title: Genetics

Course outcomes

After completion of this course students will be able to:

1) Discuss the eukaryotic gene expression mechanism and explain the regulatory components and mechanisms of eukaryotic gene expression.
2) Outline the models of recombination with emphasis on mechanism and its consequences.
3) Predict the progeny outcome of a particular cross based on mendelian inheritance principles.
4) Describe the concept of alleles as well as compare and identify the gene interactions.
5) Name and identify various sex-limited characteristics in humans.
6) Identify the type of inheritance of a particular trait/character by applying the method of pedigree analysis.
7) Classify and identify the genetic abnormalities and other characteristics based on structural and numerical alterations of chromosomes in animals and plants.
8) Discuss the basis of cytoplasmic inheritance with emphasis on mitochondrial and chloroplast DNA.
9) Outline the extranuclear inheritance of various characteristics seen in animals and plants.
10) Select the suitable molecular tool(s) for a specific genetic analysis.
11) Calculate and solve analytical problems based on population genetics.

Detailed Syllabus

Mandatory paper II: Genetics

Unit	Sub-unit	Title	Lectures
I		**Eukaryotic gene expression and regulation**	**15**
	1	Regulation of gene expression: Levels of gene regulation, DNA binding proteins, Antisense RNA molecules.	2
	2	Regulation through modification of Gene structure- DNase I Hypersensitivity, Histone modification, Chromatin remodelling, DNA methylation	4
	3	Regulation through transcriptionalactivators, Co-activators & repressors, enhancers and insulators	2
	4	Regulation through RNA processing & degradation	3

	5	Recombination: Models for homologous recombination and protein machinery	4
II	**Mendelian and Human genetics**		**15**
	1	Principles of dominance, Segregation& Independence and Assortment study using Punnet square and branch diagrams	3
	2	Concept of alleles and dominance: Co-dominance, incomplete dominance, multiple alleles & lethal alleles	2
	3	Gene interaction: Epistasis and Pleiotropy	3
	4	Sex limited Characteristics, genetic maternal effects and Concept of Anticipation	2
	5	Human genetics: Pedigree analysis and Structural & numerical alterations of Chromosomes	5
	Cytoplasmic inheritance		**15**
III	1	Cytoplasmic inheritance: mt DNA, cp DNA, Maps of mt DNA and cp DNA	5
	2	Extra nuclear inheritance: Leaf Variegation, Poky mutant of Neurospora, and Yeast petite mutant,	5
	3	Transpositions that alter gene expression: Antigenic variation in Trypanosomes, Mating type switching in yeast and Phase variation in Salmonella	5
	Molecular tools for genetics and Population genetics		**15**
IV	1	Mapping and Quantifying Transcripts: S1 Mapping, Primer Extension, Run-Off Transcription Measuring Transcription Rates in Vivo: Nuclear Run-On Transcription, Reporter Gene Transcription, Measuring Protein Accumulation in Vivo	2
	2	Assaying DNA–Protein Interactions: Filter Binding, Gel Mobility Shift, DNase Footprinting, DMS Footprinting and Chromatin Immunoprecipitation (ChIP) Assaying Protein–Protein Interactions	2
	3	Finding RNA Sequences That Interact with Other Molecules SELEX and Functional SELEX	2

		Gene Library Creating genomic Library, cDNA library, Screening DNA library	
	4	Positional Cloning Chromosome walking, chromosome jumping, application – for isolating gene for cystic fibrosis	2
	5	Genetic Markers RFLP, AFLP, SNP, RAPD and Expressed Sequence Taq (EST)	2
	6	Population genetics: Gene pool, Genotypic and allelic frequency with calculations	3
	7	Hardy-Weinberg equilibrium: Assumptions, Implications, Extensions and Testing	2

Practical:

1. Extraction and isolation of genomic DNA.
2. Quantitative estimation of DNA using DPA method.
3. Quantitative estimation of RNA using orcinol method.
4. Detection and separation of genomic DNA by Agarose Gel Electrophoresis.
5. Isolation of chloroplast from spinach leaves and estimation of its chlorophyll content
6. Isolation of Mitochondria from the cell
7. Problems on Pedigree analysis and Population genetics

References:

Unit 1

1. Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce
2. Molecular biology of the gene – 5th edition by Watson

Unit 2

1. Molecular biology of the gene - Watson
2. Genetics - Second edition by Benjamin A. Pierce
3. Principles of Genetics - D. Peter Snustad & Michael J. Simmons

Unit 3

1. Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce
2. Genetics - 5th edition Peter J. Russell

Unit 4

1. Molecular Biology by R. F. Weaver
2. Genetics: A Conceptual Approach by Benjamin Pierce

Course code:

Course title: Basics of Biostatistics

Course outcomes

After completion of this course students will be able to:

1) Describe the role of biostatistics in biological sciences
2) Apply the basic concepts of statistics in biological sciences for analysis.
3) Interpret results of the statistical analyses in written summaries.
4) Demonstrate statistical reasoning skills accurately and contextually.
5) Operate statistical software packages to conduct research studies.

Detailed Syllabus

Two unit paper: Basics of Biostatistics

Unit	Sub-unit	Title	Lectures
I		**Basics of Biostatistics**	**15**
	1	Basic concepts: Applications of Biostatistics, Data types, Statistical population & sample, Variables, Data representation	3
	2	Frequency distribution: Central tendency, measures and properties of central distribution- mean, median, mode, midrange	3
	3	Normal Distribution: Variance, Standard deviation, 68-95-99.7 Rule, concept of Parameter & statistic	4
	4	Hypothesis-formulation of Null and alternate hypothesis, Type I & Type II error, concept of One tailed & Two tailed analysis, p-value, Concept of Confidence Interval	5
II		**Parametric and Non-parametric tests for Hypothesis testing**	**15**
	1	Parametric Tests: Independent sample t-test & Paired sample t-test, One way ANOVA	8
	2	Non-Parametric tests: Chi-square analysis	2
	3	Corelation and Regression analysis	5

References:

Unit 1

1. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for Beginners,(2nd.ed.), Singapore, Pearson Education.
2. Methods in Biostatistics : B. K. Mahajan
3. Biostatistics : P. Ramakrishnan

Unit 2

1. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed.), Singapore, Pearson Education.
2. Methods in Biostatistics : B. K. Mahajan
3. Biostatistics : P. Ramakrishnan

Course code:

Course title: Microbial Biochemistry I

Course outcomes

After completion of this course students will be able to:

1) Describe the molecular details of the bioorganic molecules.
2) Discuss the structure and function of lipids, amino acids and proteins.
3) Gather and associate the significance of water molecule in cellular biochemistry.
4) Discuss and compare the metabolism of one and two carbon compounds by microorganisms.
5) Describe biological transport system and protein transport systems for folded and unfolded proteins.
6) Discuss and compare protein translocation pathways for membrane bound and periplasmic proteins.
7) Describe various pathways for drug export found in bacteria.

Detailed Syllabus

Elective paper: Microbial Biochemistry I

Unit	Sub-unit	Title	Lectures
I		**BIOORGANIC MOLECULES**	**15**
	1	**Water** - Weak Interactions in Aqueous Systems and Ionization of Water	2
	2	**Amino acids** – Structural features, classification, uncommon amino acids, titration curve	2
	3	**Proteins** – Weak interactions in proteins, conformation of peptide bond, Secondary, Tertiary & Quaternary Structure of Proteins, Thermodynamics of protein folding, role of disulphide bonds, Dynamics of globular protein folding, Chaperonins, prions Motifs, domains, & protein families	5
	4	**Carbohydrates**-Revision of Monosaccharides and disaccharides, Polysaccharides (Homopolysaccharides and Heteropolysaccharides with examples), Glycoconjugates – Proteoglycans, Glycoproteins and	3

		Glycolipids	
	5	**Lipids** - Lipid classification, Structural lipids in membranes, storage lipids, Functions of lipids: signals, cofactors, pigments,	3
II	**METABOLISM OF ONE & TWO CARBONCOMPOUNDS**		**15**
	1	Metabolism of One & Two Carbon Compounds: Carbon assimilation using Methane, methanol, methylamine in Methylotropic bacteria and Yeast Methanogenesis in Methanogenic bacteria. Citrate synthesis & CO_2 fixation in Acetogenic bacteria Chemolithoautotrophic metabolism in Carboxybacteria- Cyanide Metabolism	8
	2	Metabolism of two carbon compounds Acetate metabolism- TCA, Glyoxylate bypass & Modified citric acid cycle Carbon monoxide dehydrogenase pathway and disproportination to methane Ethanol Metabolism in Acetic acid bacteria Glyoxylate, Glycollate & oxalate metabolism- dicarboxylic acid cycle, Glycerate pathway Aspartate Metabolism	7
	TRANSFER OF BIOMOLECULES		15
	1	Solute transport revision Protein transport: The Sec system, The Translocation of membrane bound proteins, The E.coli SRP, Protein translocation of folded proteins	5
	2	Extracellular protein secretion: Sec dependent and Sec independent pathways	7
	3	Folding of Periplasmic Proteins and Drug Export systems	3

Practical:

1. Determination of pK and pI value for amino acids.
2. Isolation of cholesterol and lecithin from egg yolk.
3. Identification of fatty acids and other lipids by TLC.
4. Determination of degree of unsaturation of fats and oils.
5. Estimation of sugars by phenol-sulphuric acid method.
6. Estimation of polyphenols by Folin-Denis method.

References:

Unit 1

1. Principles of Biochemistry: Lehninger

Unit 2

1. The physiology and biochemistry of prokaryotes – 3rd edition by David White

Unit 3

1. The physiology and biochemistry of prokaryotes – 3rd edition by David White

Course code:

Course title: Research Methodology

Course outcomes

After completion of this course students will be able to:

1) Define research and its types.
2) Apply scientific methods to conduct research studies.
3) Identify and plan a suitable study design for the research studies.
4) List and differentiate between various research elements.
5) Apply the correct method of sampling to the research studies based on their suitability.
6) Collect, categorize and examine the research data manually as well as with software.
7) Compose and construct a report on scientific studies.
8) Design and facilitate an oral presentation.

Detailed Syllabus
Research Methodology

Unit	Sub-unit	Title	Lectures
I		**Research Fundamentals and Terminology**	**15**
	1	Meaning and Objective of research, features of a good research study, Scientific method	5
	2	. Study designs and variations: basic, applied, historical, exploratory, experimental, ex-post facto, case study, diagnostic research, crossover design, case control design, cohort study design, multifactorial design	10
II		**Defining research problem and sampling**	**15**
		Hypothesis, theory and scientific law: development, structure, conditions, sources, formulation, explanation of hypothesis; structure, identification, elements, classification, functions of theory; scientific laws and principles	5
		Sampling frame, importance of probability sampling, simple random sampling, systematic sampling, stratified random sampling, cluster sampling, problems due to unintended sampling, ecological and	7

		statistical population in the laboratory	
		Variables: nominal, ordinal, discontinuous, continuous, derived	3
III	**Data collection, data processing and Report writing**		**15**
	1	Methods and techniques of data collection: types of data Methods of primary data collection- observation/ experimentation/ questionnaire/ interviewing/case/pilot study methods Methods of secondary data collection- internal/ external, schedule method	8
	2	Experimental data collection and data processing Processing operations- Editing, coding, Classification, Tabulation & Types of Tables. Challenges in Data Processing	4
	3	Report writing- types of research reports, guidelines for writing a report, report format, & Citations.	3

Practical:

1. Scientific review writing and presentation

References:

Unit 1

1. Kothari, C.R., 1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited
2. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed.), Singapore, Pearson Education.
3. Fundamental of Research Methodology and Statistics – Yogesh Kumar Singh

Unit 2

1. Kothari, C.R., 1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.

2. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed.), Singapore, Pearson Education.
3. Introductory statistics - Barbara Illowsky, Susan Dean,

Unit 3

1. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed.), Singapore, Pearson Education.
2. Introductory statistics - Barbara Illowsky, Susan Dean,
3. Kothari, C.R., 1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.

Semester II

Course code:

Course title: Cell Biology and Developmental Biology

Course outcomes

After completion of this course students will be able to:

1. Illustrate cell cycle with important checkpoints.
2. Differentiate and describe meiosis and mitosis.
3. Identify and justify different phases of cell division cycle.
4. Discuss the significance of the signaling molecules for cell communication.
5. Outline the cell communication with various cell surface receptor proteins.
6. Describe basic concepts of developmental biology.
7. Discuss gamete production in mammals in detail.
8. Identify, discuss and illustrate various embryonic development stages in mammals.
9. Compare and describe types of fertilization.
10. Relate and discuss significance of apoptosis in development.

Detailed Syllabus

Course Title: Cell Biology and Developmental Biology

Unit	Sub-unit	Title	Lectures
I		**Cell division and cell cycle**	**15**
	1	Mechanism of cell division: Mitosis, Cytokines	4
	2	Cell cycle- Control system, Molecular control of cell cycle events, checkpoints	7
	3	Reductional cell division: Meiosis	4
II		**Cell signalling and Cancer genetics**	**15**
	1	Cell communication : Extracellular signal molecules, nitric oxide gas signal,classes of cell-surface receptor proteins	3
	2	Signalling through- G- protein coupled receptor & Enzyme linked Receptors	5
	3	Cancer basics, Cancer as genetic disease, Role of environmental	2

		factors	
	4	Role of- Oncogenes, Tumor suppressor genes, Genes that control cell cycle, DNA repair genes, Telomerase regulation genes, Vascularisation promoting genes. MicroRNAs and cancer	5
III	**Developmental biology Part I**		**15**
	1	Basics: Concepts of Commitment, specification and differentiation, Morphogenic gradients & initial stages of development	5
	2	Revision of Stem cells, Gamete production in mammals- sperm and egg, Sex determination	4
	3	Fertilisation-External and Internal	3
	4	Cleavage, Gastrulation and Extra embryonic membranes	3
	Developmental biology Part II		**15**
IV	1	Drosophila development: Axis and pattern formation	6
	2	Development of specific organs: Vulva formation in C.elegans, Eye lens induction, Limb development in Vertebrates	6
		Metamorphosis: types and hormonal regulation	3

Practical:

1. Study of Mitosis.
2. Study of Meiosis.
3. Study of quorum sensing: Isolation of Bioluminescent/pigment producing organisms from environment.
4. Cell signaling: Effect of Biotic and abiotic factors on Bioluminescence/Pigment production.
5. Egg inoculation and cultivating animal virus in embryonated egg (Demonstration)

References:

Unit 1

1. Molecular Biology of The Cell - Albert, Johnson, Lewis, Raff, Roberts and Walter.
2. Cell and molecular biology – Gerald Karp, Janet Iwasa, and Wallace F. Marshall
3. The Cell: A Molecular Approach - Geoffrey Cooper

Unit 2

1. Molecular Biology of The Cell - Albert, Johnson, Lewis, Raff, Roberts and Walter.
2. Cell and molecular biology – Gerald Karp, Janet Iwasa, and Wallace F. Marshall
3. The Cell: A Molecular Approach - Geoffrey Cooper
4. Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce

Unit 3

Developmental biology – 12th edition Scott Gilbert

Unit 4

Developmental biology – 12th edition Scott Gilbert

Course code:

Course title: Advanced Immunology

Course outcomes

After completion of this course students will be able to:

1) Compare and describe immune response against viral and bacterial diseases.
2) Outline immune response to extracellular and intracellular bacteria such as Diphtheria, Tuberculosis.
3) Name and compare the physiological and immunological barriers with emphasis on their significance in immune response.
4) Explain the mechanisms of generation of the diversity of the immunoglobulin molecules.
5) Explain and compare different types of immune tolerance shown in humans.
6) Name and explain various factors involved in autoimmunity.
7) Outline the treatment of autoimmune disease and other immuno-suppressive therapies.
8) Discuss and justify significance vaccines against HIV, measles and TB
9) Describe types of immunodeficiency along with treatment approaches.
10) Outline the microbial strategies of bacteria, fungi and parasites in relation to the immune response.

Detailed Syllabus

Course Title: Advanced Immunology

Unit	Sub-unit	Title	Lectures
I		**Immune system and health part I**	**15**
	1	Immune response to infectious diseases- Prions, HIV/AIDS & H5N1	5
	2	Difference in immune response to intracellular an extracellular bacterial diseases: Diphtheria and Tuberculosis	6
	3	Microbial ways of evading immune response	4
II		**Immune system and Health part II**	**15**
	1	Recent advances in immune tolerance: Central, Peripheral, T-Cell, B-Cell & Incomplete Tolerance. Tolerance generation & Duration of tolerance	3
	2	Recent advances in autoimmunity: Interplaying & triggering factors, Mechanism of Damage, Organ specific and Systemic autoimmune	4

		diseases, Proposed mechanisms for induction of autoimmunity, Animal models for Autoimmune diseases.	
	3	Transplantation & Transfusion Immunology: Graft rejection- Antigens, Role of APC's & Effector Cells, Allorecognition, Graft v/s Host Diseases, Immuno-Suppressive Therapies. Blood Transfusion: Potential Transfusion Hazards, Transfusion Alternatives	4
	4	Cancer immunology: Malignant Transformation of Cells, Tumors of the Immune System, Tumor Antigens, Tumor Evasion of the Immune System & Cancer Immuno Therapy	4
III	**Recent advances in immunology**		**15**
	1	Recent advances in Innate immunity: Physiological & immunological barriers. The innate immune response: Inflammation,Acute Phase Reaction	4
	2	Molecular basis of diversity of immunoglobulinmolecules: Multi-gene organization of Ig genes, Variable-Region Gene Rearrangements	4
	3	Mechanism of Variable-Region DNA Rearrangements	4
	4	Generation of antibody diversity, Manipulations of the immune response	3
IV	**Challenges in Immune system**		**15**
	1	Advances in Vaccine development and challenges faced for: HIV, Measles and Tuberculosis	6
	2	Immunodeficiency diseases: Primary Immunodeficiency- Defects in Compliment system, Animal Models & Treatment approaches. Secondary Immunodeficiency	6
	3	Adversarial strategies to overcome immuneresponse: microbial strategies, Immunity to Fungi & Immunity to Parasitic Infection	3

Practical:

1. Study of phagocytosis using bacterial culture/ yeast cells.
2. Collection of human blood and separation of mononuclear cells by Ficoll hypaque density gradient centrifugation and Field staining
3. SRID: for detection of immune deficiency and complement deficiency
4. Major and Minor cross matching of blood
5. Determination of Rh antibody titer (Isoheamagglutination)

References:

Unit 1

Immunology – 6th edition Kuby

Immunology: Essential and Fundamentals – 2nd edition Sulabha Pathak, Urmi Palan

Unit 2

Immunology – 6th edition Kuby

Immunology: Essential and Fundamentals – 2nd edition Sulabha Pathak, Urmi Palan

Unit 3

Immunology – 7th edition Kuby

Unit 4

Immunology – 6th edition Kuby

The elements of Immunology – Fahim Halim Khan

Roitt's Essential Immunology – 13th edition Peter J. , Delves I. Seamus

Course Code:

Course Title: Basics of Bioinformatics

Course outcomes

After completion of this course students will be able to:

1) Describe the role of bioinformatics in biological sciences.
2) Apply the concepts of bioinformatics to solve problems in research.
3) Discuss bioinformatics methods using different computational tools.
4) Perform sequence analysis.
5) Utilize major databases for various in-silico analysis.

Detailed Syllabus

Course Title: Basic of Bioinfromatics

Unit	Sub-unit	Title	Lectures
I		**Bioinformatics I**	**15**
		Scope and Importance of Bioinformatics: Aims, Tasks and Applications of bioinformatics, Challenges and opportunities	2
		Biological databases: Nucleic acid database, protein databases and structure database.	4
		Sequence alignment: Goals and types of Alignment, Study of similarities, Scoring Mutations, Deletions & Substitutions	4
		Sequence alignment methods: Pairwise alignment and Multiple sequence alignment	5
II		**Bioinformatics II**	**15**
		Gene sequence analysis: Gene sequence manipulations, analysis of Intron/Exon finding, ORF finders	5
		Primer designing and validation, Protein structure visualisation and protein classification	4
		Phylogenetic analysis: Orthologs, paralogs & Xenologs, Approaches used in phylogenetic analysis, Phylogenetic analysis databases.	6

References:

Unit 1

Bioinformatics for Beginners : Supratim Chaudhari

Basic Bioinformatics : S. Ignacimuthu

Unit 2

Bioinformatics for Beginners : Supratim Chaudhari

Basic Bioinformatics : S. Ignacimuthu

Course Code:

Course Title: Microbial Biochemistry II

Course outcomes:

After completion of this course students will be able to:

1) Describe basic aspects of enzyme kinetics.
2) Apply the knowledge of enzyme kinetics to determine the Km and Vmax of enzymes.
3) Explain types and mechanisms of enzyme regulation.
4) Categorize and explain the enzyme catalysis mechanisms.
5) Outline the basic components of signaling system.
6) Illustrate response by microorganisms under various stress conditions and varying degree of environmental factors.
7) Outline the common pathways of aromatic degradation by microorganisms.
8) Compare and describe the degradation of aromatic and alicyclic compounds by applying various strategies.

Detailed Syllabus

Course Title: Microbial Biochemistry II

Unit	Sub-unit	Title	Lectures
I		**Enzymology**	**15**
		Enzyme kinetics: Enzyme terminology, Basic aspects of chemical kinetics & Kinetics of enzyme catalyzed reactions	2
		Enzyme inhibition: Reversible and Irreversible	3
		Enzyme regulation: by Allosteric enzymes & Covalent modifications, Regulation by Multienzymes complexes & Multifunctional enzymes	4
		Mechanisms of enzyme catalysis: five themes mechanisms of enzyme catalysis: serine proteases,ribonucleases, triosephosphate isomerase, lysozyme, lactate and alcohol dehydrogenases	5
		Effect of pH on enzyme activity, enzyme action by x-ray	1

		crystallography, nerve gas and its significance	
II	**Signalling & Stress**		**15**
		Introduction to two-Component Signalling Systems, Response by facultative anaerobes to Anaerobiosis, Response to nitrate and nitrite	4
		Effect of oxygen and light on the expression of photosynthetic genes, Response to osmotic pressure and temperature, response to potassium ion and external osmolarity	3
		Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity, Chemotaxis, photoresponses, aerotaxis	3
		Bacterial development and Quorum Sensing: Myxobacteria Bioluminescence, Systems similar to LuxR / Lux I inNonluminescent bacteria	2
		Bacterial response to environmental stress: heat –shock response, repairing damaged DNA, the SOS response, oxidative stress	3
III	**Microbial Degradation**		**15**
		Degradation of Aromatic and alicylic compounds: important organisms, mixed culture & genetic manipulation	4
		Common pathways of aromatic degradation: aerobic& anaerobic attack on aromatic ring: phenolic pesticides, terminal aromatic metabolites of pesticides. Industrial pollutants- phthallic acid esters, ligosulfonates, surfactants, dyes & aromatics released during combustion.	5
		Biotransformation of aromatic compounds: Catabolism of naphthalene, Phenanthrene and Anthracene.	3
		Biotransformation of alicyclics, aliphatics, branched chain alkanes & alkenes and halogenated aliphatics	3

Practical:

1. Enzymology

   Purification of an extracellular enzyme (β-amylase) by salting out and dialysis.

   1a. Isolation of amylase from Aspergillus species.

   1b. Purification of amylase from Aspergillus species.

   1c. Dialysis of salting out protein
2. Enzyme kinetics- effects of enzyme concentration, substrate concentration, pH, temperature and inhibitors on enzyme activity
3. Adaptation of *E.coli* to anaerobiosis
4. Microbial degradation of polycyclic aromatic hydrocarbons (PAHs)- Enrichment, isolation and screening of bacteria

References:

Unit 1

1. Fundamentals of Biochemistry – Donald Voet, Judith Voet
2. Biochemistry – 4th edition Lehninger

Unit 2

1. The physiology and biochemistry of prokaryotes – 3rd edition by David White

Unit 3

1. Biotechnology H.J. Rehm and G. Reed (ed.), Volume 6a. Biotransformations, Verlag and Chemie, 1984
2. Introduction to bacterial metabolism Doelle H.W., Academic Press, 1975 Microbial ecology, Atlas RM and Bartha, Addison Wesley Longman Inc. 1998

Evaluation Pattern:

33% to 50% continuous internal evaluation and remaining at the end of each semester.